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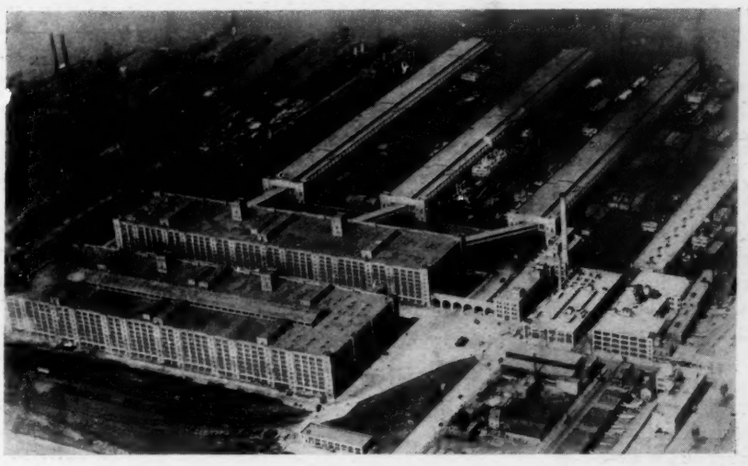
THE BROOKLYN ARMY SUPPLY BASE

An Achievement of the Construction Division of the Army

By CAPTAIN E. P. ANTONOVICH, U. S. A.

Now that more than a year has passed since the close of hostilities, one may get a clearer perspective of some of the phases of the conflict, especially those operations not attended by the glory of the battlefield, but which, none the less, contributed to the proud achievements of American arms.

As one reviews these various phases that have characterized the war, one is deeply impressed with the colossal scale of the operations. Comparable in magnitude with such brilliant attainments as the raising and equipping of an army of four million, and the safe transport of two million troops across the seas in the face of an insidious foe—accomplishments which a few years ago would have been considered visionary—is the achievement of the Construction Division of the Army, the organization that constructed the Brooklyn Army Supply Base.



AEROPLANE VIEW, BROOKLYN ARMY SUPPLY BASE

The far-flung operations of the Construction Division, embracing activities in every State of the Union save one, in Porto Rico, the Canal Zone, Alaska, Hawaii, the Philippines and constitute an achievement which Vladivostok, for magnitude and expeditious execution, is without parallel in engineering history.

When it is realized that, in addition to providing housing for an Army of 4,000,000 men in thirty-two large camps (each a fair-sized city in itself), it was necessary to construct ports of embarkation, munition plants, air stations, hospitals, terminal facilities, involving the expenditure of over $1,200,000,000, one may form some idea of the scope of the gigantic building program undertaken and successfully accomplished by the Construction Division.

The Commissioned Personnel of this Division, who directed the energies of approximately 400,000 civilian workers, totalled about 1500 officers, drawn into the Army almost entirely from the civil professions. In their ranks were to be found architects, city planners, civil mechanical, electrical, water supply and sanitary engineers, and constructors, and their work is a lasting monument to the versatility,

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GETTING THE MOST OUT OF THE CAMP

By G. L. HOSMER, '97

Prof. of Topographical Engineering, M. I. T.

That there is something in the Surveying Camp plan which appeals to all who have attended is shown by the fact that we hear today the same comments upon the surveyor's experience that were heard in the days when the school of Topography was given by Dean Burton. In those days the men were enthusiastic about the summer school and years afterward looked back upon it as one of the finest experiences they had during their school life. The summer camp does not wear out. When the Camp was opened as a required part of Course I some were skeptical about the results being as satisfactory as when the work was optional and the group small. Yet the spirit of the Camp is much the same as that of the old Summer School.

The opportunities both for instruction and for recreation are unusual. What a man gets out of them, however, depends chiefly upon himself and how he prepares

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THE AMERICAN RAILROAD SITUATION

By ELISHA LEE, '92

Regional Vice-President of the Pennsylvania R. R.

The general situation now existing as to the earning powers of the railroads is, I presume, known fairly well to all of you. In two years and two months of Federal operation, the Government incurred a deficit of over $600,000,000 after providing for the rentals due to railroad companies. These rentals were determined upon the conservative, but on the whole, reasonably fair, basis of the average net earnings of the three years ended June 30, 1917, usually called the "test period." Such was the condition of depleted net earnings in which the railroads returned to their owners. The two final months of federal control were especially unfavorable in their results, unusually severe weather conditions aggravating the effects of the more permanent factors in the situation.

Let us now consider some of the factors, other than weather conditions, which contributed to this state of affairs.

In 1915, railroad wage and labor conditions were about what we used to call "normal." In that year, the average wage paid per man in the Operating Department, on the portion of the Pennsylvania System which we used to call the "directly operated lines," (that is, the lines between New York and Washington, and Philadelphia and Pittsburgh, with their branches) was something less than $840 per year. By the opening of 1920, this had risen to a rate of nearly $1600 annually. The average wage per employee had practically doubled. Meanwhile, the number of operating employees, (excluding the executive forces at Broad Street Station) had risen 31 per cent, while the total pay-roll jumped from $105,000,000 in 1915 to $240,000,000 in 1919. The entire cost of rendering service, due to the factors of higher wages and more men, had thus increased nearly two and one-half fold.

Has the increase in the amount of work done in recent months, compared with the volume of five years ago, been commensurate with the increase in the number of men required to do it? Or has it been commensurate with the still greater

(*Continued on page 16*)

TELEGRAPHY OVER OPEN CIRCUIT BARE WIRES LAID IN THE EARTH OR SEA

By MAJOR GENERAL GEORGE O. SQUIER
Chief Signal Officer, United States Army

The "key problem" in the procurement of essential Signal Corps supplies in the United States during the World War, curiously enough turned out to be the production of the necessary braiding machines for finishing insulated wire. The bare wire itself could be obtained, the rubber insulation could be obtained, even the cotton thread with which the braiding was made could be obtained, but the necessary machinery for braiding the thread, which finally led us into the intricacies of the procurement of steel, was never anything like adequate for the enormous demands required in the field.

The braiding capacity of the entire United States, as of September 1, 1919, was about 8,000 miles of twisted pair insulated wire per month while the requirements for the American forces alone at that date were about 40,000 miles a month. On October 1, 1918, the Allied Council reached the decision that beginning March 1, 1919, it would be necessary for the United States to furnish all of this type of wire used by the Allied armies in the field, and the estimated minimum requirements for this purpose were equivalent to four times around the earth a month. To supply this amount of insulated wire would have required cargo space for overseas shipment in the amount of 14,000 ship tons a month but had it been possible to use single conductor bare wire in place of the twisted pair insulated wire, the space required would have been reduced to 2,500 ship tons a month, thus releasing the balance for transportation of food, and other vitally necessary supplies.

Three Media for Electric Wave Propagation

The following reasoning led to the carrying out of the experiments to be described:

Since we can already communicate by radio means between one submarine and another submarine, both completely submerged, it was considered that connecting two such stations by a submerged copper wire could have no other effect than to facilitate the propagation of the electric waves between the stations.

It was considered possible that the behavior of earth or water under the action of high frequency currents might exhibit greatly different properties from those with which we are familiar at direct or low frequency currents.

Abstract of paper presented to the National Acadamy of Sciences at the session held at the National Museum, April 27, 1920.

It was realized that whatever high frequency energy losses might occur in the case of bare wires laid in earth or water, yet the over-all efficiency would be higher than in the case of radio space transmission where the plant efficiency is so very low.

It was noted by the writer in September, 1910, and discussed by him in April, 1912,* that the three electrode audion could be used as a potentially operated device on open circuits. This arrangement was considered suitable for the reception of the signals over bare wires in earth or water.

Preliminary Experiments

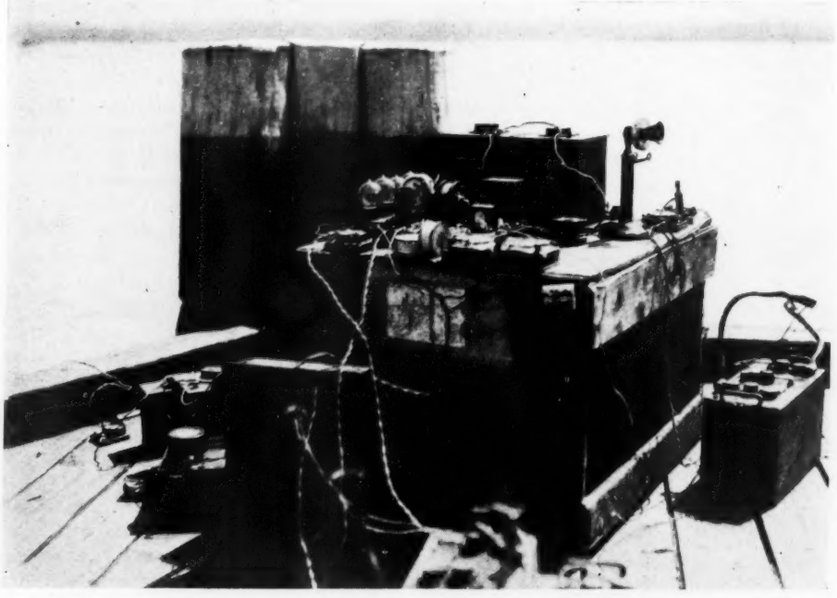
The first experiment was an extremely simple one as follows: A bare No. 18 phosphor bronze wire, such as is used for the Signal Corps field antennae, was laid across the Washington Channel of the Potomac River from the War College to the opposite shore in Potomac Park. It was paid out from a small boat with sufficient slack to lie on the bottom of the river. A standard Signal Corps radio telephone and telegraph set, SCR 76, was directly connected to each end of the wire, one set serving as a transmitter and the other as a receiver. At the receiving end of the line the bare wire was directly connected to the grid of the receiving set and the usual ground connection left open. A frequency of about 600,000 cycles a second was used and the line tuned at each end by the usual methods. Excellent telegraphy and telephony were obtained. Care was taken to make this preliminary experiment as simple and basic as possible and precaution taken to insure that the wire itself should be bright and clean and entirely free from any grease or other insulating material.

The success of this simple experiment immediately led to more thorough consideration of the entire subject.

One of the questions to be investigated was the general efficiency of the electron tube when used as a potentially operated instrument. The following experiment was made:

A strip of wire netting was buried in the snow outside the office of the Chief Signal Officer in Washington and a wire attached thereto leading to the second story of the building. The upper end of this wire was connected directly to the grid of an electron tube. The reason for connecting the grid to the upper end of the antenna is of course obvious if we are to use the tube as a potentially operated device. It was necessary for maximum sensitiveness to connect it to the point of maximum potential of the an-

*Journal of The Franklin Institute, April, 1912, "Some Experiment in 'Wired Wireless' Telegraphy for Field Lines of Information For Military Purposes" by Major George O. Squier, Signal Corps, U. S. Army.



TRANSMITTER FOR SUBMARINE WIRED WIRELESS
This transmitter was used in submarine wired wireless experiments between Fort Hunt, Virginia, and Fort Washington, Maryland. The bare wire over which the messages were sent is seen going over the edge of the dock at the left of the picture

RECEIVING APPARATUS

This simple receiving apparatus was used at Fort Washington, Maryland, in the submarine wired wireless experiments of April 15, 1920.

tenna which in the case of a linear oscillator occurs at the open end. By this arrangement, messages were readily received from distant points in the United States.

These two simple experiments, above described, demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water and the use of an electron tube as a potentially operated device for the reception of signals.

Summary

In carrying out these investigations and in attacking the problems from various angles, the research staff of the Signal Corps laboratory at Camp Alfred Vail, Little Silver, New Jersey, was directed to carry out experiments on bare wires laid on the surface of moist ground and also buried in earth. The staff at the Signal Corps research laboratory at the Bureau of Standards was directed to investigate fundamentally the transmission of electromagnetic waves over bare wires in fresh water. In addition to this, the engineering staff of the Office of the Chief Signal Officer has carried out from time to time certain experiments of a more or less crucial character which have come up for solution in the prosecution of this work at the other laboratories.

The phenomena associated with the transmission of high frequency waves over bare wires in earth or water are obscure and complex, and the writer has formulated no definite theory at the present time.

Results Obtained

Telephone and telegraph communication has been established between Fort Washington, Maryland, and Fort Hunt, Virginia, across the Potomac River, below the City of Washington, over a distance of about three-quarters of a mile, by the use of a large No. 12 phosphor bronze wire laid in the water to connect the stations. The transmitter consisted of an electron tube oscillator which delivered a current of about 270 milliamperes to the line at a frequency of about 600,000 cycles a second. At the receiving end of the line an electron tube and a 6-stage amplifier were used without any ground connection. With this arrangement good tuning was obtained at both ends of the line, and telegraphic and telephonic transmission secured over the bare wires immersed in fresh water.

A resonance wave coil has been developed. The coil is in the form of a long helix wound with a large number of turns on which stationary waves are produced by the incoming radio signals. An electron tube is used as the detector, the grid being connected to the point of maximum potential on the coil. The wave coil may be used either as a part of the usual antennae system or a part of a line wire, or it may act itself as the antennae for picking up the energy of the signals. In the latter case the coil may be either free at both ends or grounded at one end. Good results have been obtained in either case. It has been also found that the open coil has directional properties and can be used as a goniometer not only for horizontal measurements but for vertical measurements as well. This form of radio goniometer has the great advantage that it permits not only of determining the plane where the signals are strongest but also the direction from which such signals proceed.

Telegraph and telephone communication has been also established between two stations at the Signal Corps Research Laboratories at Camp Alfred Vail, Little Silver, New Jersey, using a bare No. 16 copper wire buried in the earth to a depth of about eight inches to connect the stations. The distance between the two stations was three-quarters of a mile. Frequencies as high as one million cycles a second were used. Similar communication has been carried on over a bare wire one and three-quarter miles long laid on the surface of moist earth. The current at the transmitting station in these installations was about 100 milliamperes. It has been shown that a bare wire buried in moist earth with the distant end open can be tuned both at the transmitting end and at the receiving end.

Suggestions

In the older art of ocean telegraphy, the elaborateness of line construction has already reached a practical limit. The best Atlantic cable of the present day is limited in operation to electric waves of frequency of the order of magnitude of 10 per second. The electrical construction is such as to limit the voltage employed on any long cable to from 50 to 80. The relative values of the line constants in any ocean cable preclude the possibility of ocean telephony.

It is believed that the most promising hope of improving the line construction for ocean cables is to abandon the present method of design and construction and to start with the simple case of bare wires in water using high frequency currents and to study the changes necessary to produce optimum transmission.

The use of a high frequency "carrier" has the inherent advantage that the distortion phenomena accompanying present methods of long distance transmission are eliminated, and we are principally concerned with the problem of reducing attenuation. The most suitable voltage may be employed and present multiplex methods may be utilized. The electron tube is available for both the generation and the reception of the waves.

During the last few years an intensive study has been made of the surface conditions of wires necessary to produce the emission of electrons, and to this intensive study, both by universities and industrial research laboratories, is due the high state of efficiency of the present electron tube. Nothing short of a similar study of the surface conditions of wires for preventing the emission of electrons instead of producing them, will finally give us the wire conductor of the future.

The development of types of resonance wave coils, both open at one and at both ends, for general radio work offers an interesting field for investigation. This involves the study of the electron tube as a potentially operated device. The application of such coils properly designed for specific purposes may lead to the practical solution of a number of radio problems such as directional effects, and wave coil antennae of very small dimensions.

SOME COUNTRY TROLLEYS, THEIR ORIGIN AND FUTURE

By LIEUT.-COL. FREDERICK J. WOOD

In these troublous times with all the electric street railways seeking relief by increase of fares, reduction of service, or entire abandonment of franchises, it may be of interest to review briefly the origin of many of the roads of Massachusetts, in as much as knowledge of the past is often the best clue to the future.

Roughly the street railways of Massachusetts may be divided into three classes; first those serving compact centres such as the Boston Elevated, second those connecting such centres, such as the roads from Boston to Lynn and other large cities within short radius, and third the country roads which extend over many miles to connect small places which of themselves offer little inducement for such facilities. The large mileage of the third class gives them a prominence out of all proportion to the business which they do or the population which they serve.

Roads of the first class are the natural growth resulting from the increased demands for service. Originally all these were horse car lines with very small beginnings, sometimes built to operate along but one street, and at the most merely connecting the down town section with a certain section of the suburbs. In due time such lines were consolidated and the change to electric motive power was made. It may be mentioned in passing that the introduction of horse cars in Boston falls within the history of the last seventy years.

With the perfection of the electric trolley system most extravagant ideas arose of the ability of the new method to perform what had previously been done by horses. The success of the city roads under electric propulsion encouraged imitation in many smaller places where the investment might have been justified if made with more moderation. But it soon became a common saying that an electric road could pay anywhere and because his cousin in Boston could reach a car by walking not more than a block, the citizen of a far smaller place had to have the car lines wind through the various streets and avenues of his particular borough, when a single line through the main street was all that could have been justified.

But it was among the roads of our third class that the wildest speculation was encouraged. The idea that an electric road could pay anywhere was, for the purposes of promoters, extended for this class to say that one could climb any hill and turn any corner. Many of these roads were hurriedly built by contractors who speeded operations that they might sooner attain their goal which was to sell the road to some confiding investors. Under such operators the franchises were secured in the shortest possible time and many later superintendents had occasion to regret the haste with which every demand of the local governments was conceded and allowed to be inserted in the franchise. It is common to find that hard pine square poles must be used to support the wires, that the tracks must be taken up and moved whenever the selectmen demand, and that a standard of paving not to be found anywhere in that particular town, can be demanded of the railway company.

In laying out their road the promoters sought every influence and often engaged the local surveyor to act as their engineer, which doubtless accounts for the erratic alignments which have puzzled so many engineers who later had occasion to examine the property. Private owners also had their say in deciding matters and many a track curves most unjustifiably today because a favorite tree of somebody was in the direct line. The tree may be gone by this time but the kink in the track remains just the same. Abrupt crossings from one side of a street to the other were made to do away with private owners' opposition and often for the same reason a most disadvantageous detour would be made. All such were small matters to the promoter, intent only upon getting through and selling, but each remains today, an added expense in operation.

In the construction many matters were slighted if they did not appear on the surface and inferior material was too often used. The rigid requirements of the franchise were generally evaded in the first work, and left for later owners to fight out. The writer has often seen town officers attempt to use such franchise terms as a club, saying that they could and would ask much more if compliance was not had with their one demand, but fortunately the railroad commissioners of several years ago ruled that unreasonable requirements could not be enforced.

Such country roads being new and needing practically no repairs for the first six or eight years seemed to be good properties and paid good dividends in their early days but an examination of the returns found in the reports of the railroad commissioners will show that they met with a sudden falling off when their average age was about eight years, since which time few of them have been in the class recommended for investment. Then extensive renewal of the ties were necessary and since it was necessary to dig up the whole length for examination it was generally deemed cheaper to renew all the ties at once than to make several jobs of it.

The method of estimating earnings on a proposed road was in keeping with the rest of the production. Taking the gross earnings of a sound existing road serving a compact district and dividing the same by the population of the town gave what was called a "per capita" which was then applied to every person resident within any of the towns to be touched even if only a scant corner was crossed. Such figures naturally seemed to justify heavy investment which experience has shown to have been inadvisable. Some enthusiasts went further with their estimate of earnings and included tiers of towns one, two and three removed from the proposed line, scaling down the "per capita" in accordance.

It is common knowledge now that such lines were destined to fail ultimately and that such failure has been hastened by the increased use of the automobile in rural regions, and the question now arises, what is to become of them. When one considers how small a percentage of the time the track is in use, it causes wonder that it was ever considered advisable to make the necessary investment. On a ten mile line with hourly service each way for eighteen hours a day, each rail bears a load for only seven minutes of the entire twenty-four hours.

But the rails are there, in many places, and their cost has long ago been absorbed in foreclosure proceedings so there may yet be hope arising in Detroit. If the heralded Ford railway car can be perfected it is quite possible that many of our country lines can be utilized to advantage. The track is already made and can be bought for its junk value. The cost of the coming cars is little and there certainly is some business to be picked up along the poorest of the lines. It is safe to say that with conservative figuring and business operation, the Ford cars could be operated to the advantage of all concerned.

COLD STORAGE EGGS

Eggs twelve years old—still safe and sound! In the biological laboratories, thesis research has shown that cold storage eggs of this age are in good condition, suitable for consumption as food. Although the eggs have been frozen solid during the time in which they have been in storage, some 20,000,000 harmless bacteria and about 100,000 intestinal bacteria have been found in every cubic centimeter of egg examined.

THE LAW OF GRAVITATION

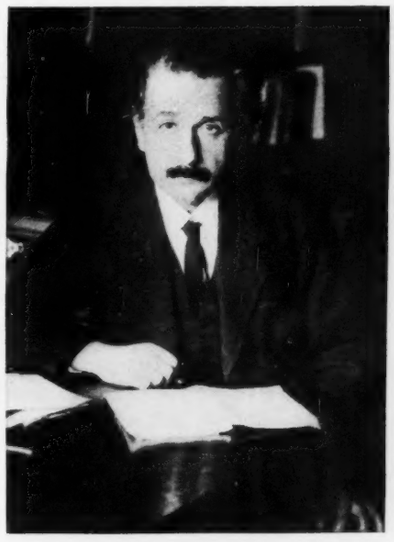
By PROF. E. B. WILSON, M. I. T.

Newton's law of gravitation that the attraction between two masses varies directly as the product of the masses and inversely as the square of the distance between them has been found by astronomical observations to be extraordinarily accurate. It cannot be proved to be very accurate by direct measurement of the forces between two masses in a laboratory experiment, like the Cavendish experiment which Professor Derr has several times shown to the Sophomore Class this past year as a lecture experiment, because the forces are so small. It can hardly be expected that Newton's law for attraction differs from other physical laws, such as Boyle's law for the pressure and volume of gases, in that it is absolutely accurate like a geometric theorem whereas they are merely approximately true,—unless the law be really a definition in disguise.

Einstein has proposed a modification of the law of gravitational attraction, a very slight modification so far as the effect on ordinary astronomical phenomena is concerned. To put the matter crudely his result may be stated for ordinary planetary theory as introducing, in addition to the inverse square term, a term in the inverse cube of the distance. This term increases in relative magnitude as the distance decreases. It is sufficiently small not to change especially the calculated astronomical events with respect to all other planets but Mercury. Yet for Mercury the planet nearest the sun, it produces a change just sufficient to account for the advance of 43″ per century in Mercury's perihelion.

Anybody can propose such a change in Newton's law as to account for this slight advance in Mercury's perihelion without introducing discrepancies of note anywhere else in the solar system. But Einstein proceeded by another path and deduced the change in the Newtonian law, so that he had an observational check on his theoretical considerations. Fundamental to his notions is the idea of measurement. Every type of measurement presupposes some standard measure and some method of applying it. In geometry it is the axiom of superposition which enables us to make measurements of lengths. We assume that a segment AB may be laid off from any point O along any direction OP, that it may be laid off any number of times in succession, and thus by the theory of commensurables and of limits (in the incommensurable case) any two lines may be compared. Scientific measurement of rectilinear distance is as old at least as Euclid.

Time measurement is newer. One interval of time cannot be picked up and laid down a number of times upon another like a meter stick. It is necessary to devise some uniformly running machine which shall mark equal intervals of time like the rotating earth (for days), the hour glass (an old and not very accurate instrument), the pendulum, clock, tuning fork, etc. And the different time pieces must be standardized against each other or calibrated. Moreover, although it is easy to carry the same meter stick from New York to London, it is no simple matter to carry the same timepiece



(Photo from Wide World Photos)
DOCTOR ALBERT EINSTEIN
Dr. Einstein's theory on Relativity, the diversion of a ray of light in the field of gravitation of the sun, marks a turning point in the history of physical science.

from 450 B. C. to 3000 A. D. Velocities and accelerations depend for their measurement on space and time. The general theory of measurement of even the simpler dynamical quantities is therefore no simple matter when critically examined.

For the purpose of comparing distances or times, light is one of the most accurate means. Through the study of interference fringes exceedingly small distances may be measured. Clocks may be standardized over long distances by light or by wireless signals which are waves of invisible light. The velocity of light is a constant in vacuo. Einstein uses light as his fundamental means of calibrating both time and space measuring instruments. His first postulate of relativity is that the velocity of light as measured by different observers in uniform motion relative to each other is always the same. This seems to be verified experimentally but is, of course, very different from what happens with moving objects. For example, if one observer measures the velocity of a bullet as 1000 feet per second, an observer moving relative to the first at 100 feet per second in the direction of the bullet would measure the velocity as 900 feet per second. Einstein, however, finds that to subtract two velocities u and v one must have

$$\text{not } u - v \qquad \text{but } \frac{u - v}{1 - \frac{uv}{C^2}}$$

if c is the velocity of light. For small velocities u and v this result is nearly u - v. But if u is the velocity of light c itself then the fraction becomes merely c, —or in other words any velocity subtracted from that of light is still the velocity of light. This is as it should be if all observers, no matter what their relative velocity may be, are to find the same value for the velocity of light.

With respect to gravitation Einstein postulates that an observer cannot tell whether he is at rest in a gravitational field or in uniform acceleration or, in other words, he cannot tell how much of the force he feels is due to the attraction of gravitating matter and how much is due to his own acceleration. Thus a person dropping in an elevator with constant acceleration of a fraction fg of g may (1) take cognizance of his acceleration and claim that his weight W=Mg is due to the earth's gravitation but the force on him is F=W-Mg=Mg(1-f) due to his acceleration, or he may (2) ignore his acceleration and consider that the force is due to a less attracting earth. This seems a bizarre notion, but works out well when followed to its conclusions. In particular Einstein is led to make a large revision in our notions of time and space and to explain the gravitating effects of matter as illusions of the same sort as centrifugal force. As centrifugal force comes into play only when we try to ignore rotation and replace its effects by the centrifugal force, so gravitational force is introduced only when we try to ignore the actual relations between space and time.

It is really futile to attempt to explain in a few words the mathematical or physical or philosophical significance of Einstein's work on gravitation. The desire of the "man in the street" to understand the matter or at least to get a few sensational thrills from the work is both intelligible and laudable, but it is safe to say first that very few persons in the world really understand Einstein (he is said to have estimated their number at not exceeding twelve) and that for engineering and most physical purposes the theory may be ignored except by a few specialists.

For a general treatment of related matters see "Space, Time and Gravitation" by E. B. Wilson, Scientific Monthly, March 1920 and "Relativity Theories in Physics" by R. C. Tolman in a forthcoming number of the General Electric Review, Schenectady.

THE MERCHANT MARINE

By H. L. FERGUSON

President of the American Shipbuilding Corporation, President of the American Chamber of Commerce

It is too generally assumed that we now have a merchant marine because we have a very large tonnage of ships built or under construction and have started out on a large scale to operate these vessels. The ability to build good ships and the vessels themselves are but two of the main elements of a merchant marine. In addition to these are required the trained officers and men for the operation of the ships; the classification of the vessels not only during the construction but in operation, so that favorable insurance may be obtained; the insurance of the vessels and of the cargoes; agents and agencies in all of the ports visited to represent the owners or operators in a responsible way; banking and credit facilities for the service of ship operators, exporters and importers.

These are all essential elements in the successful maintenance of a merchant marine. The skill and experience required by all interested in the continued success of our marine can only be acquired by a long term of apprenticeship and hard work. That each of these elements should be thoroughly American is beyond question. The necessity of being able to build our own vessels was demonstrated so thoroughly by the war that further argument is not needed. We spent almost four billion dollars to acquire vessels that could have been had for probably half that much had we possessed the facilities and men before the war. That the officers and seamen on the ships should be American is also beyond question because merchant ships nowadays in time of war really become a component part of the nation's system of defense and offense. All merchant vessels in the great war were armed and supplied with naval gunners for their protection. In fact the greater part of the merchant vessels were manned throughout by the Navy as well.

The reasons for American ships and American seamen apply with equal force to American classification, insurance and agencies abroad. It is but natural that the nationals of a country can be depended upon to serve that country better in every way than will the nationals of a competitive country.

The history of a hundred years before the great war demonstrated clearly that under the conditions and laws then existing Americans were not attracted to the sea in large numbers and American investment on the sea was not considered good. There is no reason for assuming that competitive conditions after readjustment to peace has taken place will be materially different from what they were before. In fact the absolute necessity of the nations of Europe to put themselves on their feet financially will bring about the keenest competition all over the world.

It is therefore probable that unless preferential treatment of some kind is given to American ships in the foreign trade we will revert in time to our former position. Preferential treatment is required for the reason that costs of building and of operating are greater in the United States than abroad, owing to our higher wage scale and the much higher scale of living demanded by all Americans, and also because we have not yet acquired the skill and experience to operate in competition with our more skilled neighbors. Even if costs of building and operating were the same, it is probable that some aid would be required to get established firmly.

The form that this preferential assistance should take has been the subject of much debate for many years. Some advocate an outright subsidy, others a policy of discrimination against ships not engaged in the trade of their own countries, and others advocate preference for our shipping in the matter of railroad rates on export goods and a preference for the officers and seamen in the matter of special pay to them from the Government for becoming a part of the auxiliary naval reserve.

Whatever is done the result to be accomplished must be that the investment of American capital in ships and shipping will be rendered attractive both as to principal and as to a reasonable return in the matter of earnings.

At the present time a great deal is being written and said about the sale of the vast fleet now owned by the Government and operated under lease by private companies. The price at which the newly built ships are to be sold is a matter of considerable argument. It would seem that if the Government intends to have a policy of preferential treatment for its own shipping, that policy should be enunciated before the sale of its ships in order that a better price may be realized for the ships by the Government and the purchaser may know what he has to expect. The same reasoning applies with equal force to the sale of the interned German vessels. If the Government does not intend to do anything it is only fair that the prospective purchaser should know that. If the vessels are sold without any policy and if none should be adopted, it is in my judgment inevitable that the major part of them will pass into foreign hands.

In seeking a proper governmental policy, it seems that one which could be made applicable in all fairness to the commerce of any country would be the best one. That policy in brief, is one which will give preferential treatment to our ships in our own trade with any given country, and will give to the vessels of that country the same treatment. But, on the other hand, when the vessels of a country which is not interested in the trade except as a common carrier, seek to enter that trade known as the indirect trade to such country, there shall be imposed upon such common carrier an additional burden. The principle underlying this policy is that the trade between any two countries is essentially their own business, and that every country should have a marine proportionate to its needs in order that it may maintain both its economic and political independence.

GETTING THE MOST OUT OF THE CAMP

(Continued from page 1)

for the trip. A man may be able to "get through" his work by the hasty preparation made at the time, but he may get twice as much out of it if he knows beforehand what is to be done and what opportunities are offered.

The work of the Camp includes Topographical Surveying, Railway Fieldwork, and Hydrographic Surveying. The work is conducted as nearly as possible as it could be in regular engineering practice. Surveys in general are not made just for the sake of surveying but are made for engineering purposes. The manner in which the work is conducted depends upon the particular purpose of the survey. If a student is posted on the requirements of different kinds of engineering projects he is in a position to judge of the relative importance of the different parts of the work. No one can tell what measurements should be made or how accurately or how frequently they should be taken unless he understands pretty well the use to which they are to be put. Failure to look beyond the immediate problem is one reason why some men get so little out of their work.

The most interesting part of the fieldwork is that in which the student has to

A CANOE TRIP TO ROUND LAKE

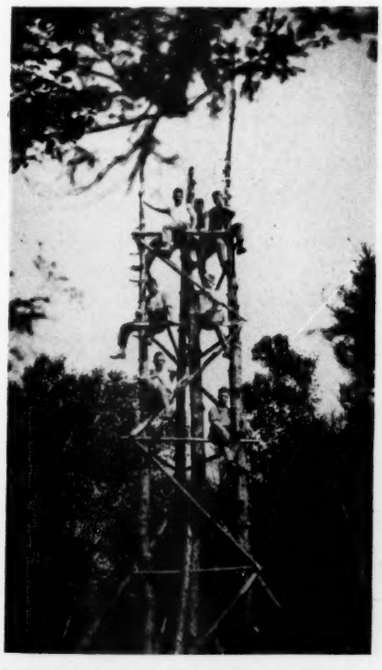
PLANE TABLE SURVEYING AT CROSBY POINT

plan his own surveys. It is when one is thrown upon his own resources that he learns the most. Before such work can be done to advantage there must necessarily be some drill work as a foundation. So far as possible the work is planned so that each survey is carried on in new territory, and the student has the satisfaction of knowing that he is mapping a region that is new to the instructors as well as to the students.

And in the recreation Camp one may have a good time, but he misses many opportunities if he does not look ahead and plan his outing. Many students find themselves on the shore of a very interesting lake with no boat or canoe, and no way to get one at short notice. Some who enjoy fishing discover that they did not procure a license before starting. Many would like to go on camping trips but have provided no equipment. Graduate Boy Scouts would do well to pack along some of their old equipment.

If one is interested in nature here is a chance to see many game animals and birds, water fowl and song birds, as well as many kinds of trees, especially evergreens, that are not seen farther south. How many can recognize the different varieties of evergreens? To the average man everything is a "pine" tree, unless he has taken pains to look up this matter beforehand and is on the alert for the different varieties.

So the man who is booked to go to Camp this year will do well to remember that the Institute has furnished a beautiful location and fine equipment, and the faculty will furnish a program. What he gets out of the Camp will depend largely upon himself and how well he has prepared.



BUILDING A FORTY FOOT TOWER AT TRIANGULATION STATION

BROOKLYN ARMY SUPPLY BASE

(*Continued from page 1*)

genius and patriotism of American men in the technical professions.

At the outbreak of the great conflict, one of the most difficult problems to be met was the congestion at ports on the Atlantic seaboard, due to the shipment of huge quantities of supplies and equipment to the Expeditionary Forces in France. To correct this condition, it was necessary to provide mammoth storage facilities. These facilities, known as Army Supply Bases, were constructed at Boston, Brooklyn, Newark, Philadelphia, Norfolk, Charleston and New Orleans. Typical of these bases, and largest in size, is that at Brooklyn.

Situated on the eastern shore of New York Harbor, the Brooklyn Army Supply Base rears its huge and majestic masses, and claims a foremost place among the great buildings of the metropolis—the city noted the world over for its colossal structures.

The project, constructed at a total cost of approximately $32,000,000, consists of two large warehouses, "A" and "B," an Administration Building, a Power Plant, a Repair Shop, three double-decked Piers and one open Pier. It occupies a total area of 100 acres and contains 4,000,000 square feet. or nearly 100 acres of storage space, and 17 miles of railroad trackage, providing storage for about 1300 railroad cars.

The property fronts on the deep water channel at the pierhead line, and is immediately adjacent to the Bay Ridge Terminal of the Long Island and Pennsylvania Railroads and has direct connection with the New Haven Railroad over Hell Gate Bridge, which gives this Base unsurpassed transportation facilities.

Warehouse "B," containing a floor area of 51 acres, is said to be the largest storage building in the world. It is 980 ft. long and 360 ft. wide, and is eight stories and basement high. It contains a lengthwise court, 66 ft. wide, provided with two railroad tracks, three electric travelling-cranes, and a skylight roof which permits of the receipt and shipment of freight regardless of weather conditions. A series of cantilever balconies projecting into the court permits the receipt and direct assignment of freight to any forty foot section of building of any floor. Goods may be easily and quickly transferred direct from cars to these balconies by means of the travelling cranes.

The three double-decked piers are the largest in New York Harbor, each being 150 ft. wide and about 1300 ft. long. This group of piers, together with the open pier, will accommodate at one time, twelve to eighteen vessels of the largest type.

A longitudinal pile bulkhead, 1300 ft. long, backed with riprap, was constructed, and to accommodate vessels of the greatest draft it was necessary to dredge slips to a depth of 38 ft. In all, 1,700,000 cubic yards of dredged material were removed.

COURT IN WAREHOUSE B
Note the cantilever balconies for receiving freight direct by rail.

The system of circulation at the Brooklyn Base is most successful. Material may be easily transferred from any part of the warehouses to the side of a waiting ship over most direct routes. Two distinct series of lines of communication on separate levels, between warehouses and piers, are provided. One series consists of routes through tunnels under Warehouse "B" and First avenue, across dock floor of Warehouse "A" and across street to lower decks of piers. The other consists of routes through third floors across connecting bridges over court and streets, to upper decks of piers.

All structures, with exception of piers, are of reinforced concrete throughout. Columns in warehouses are spirally reinforced and are spaced 20 ft. in each direction. The floors are of two-way reinforced flat slab type, plain and deformed bars being used. The lower three floors were designed for a live load of 300 lbs. per square foot and the floors above for 250 lbs. The excellent underlying soil

VIEW LOOKING NORTHEAST

The yards in the foreground have a total trackage of 17 miles, providing storage for about 1300 railroad cars.

conditions permitted the use of spread footings, allowing for a pressure of three tons per square foot on subsoil. Where inferior conditions were encountered, concrete piling and continuous mat footings were used.

The substructure of the piers consists of untreated wood piles, 45 to 60 feet long, in clusters, capped with reinforced concrete. Piles were driven by means of water jet and steam hammer to fine sand and clay bottom. The columns and roof trusses of superstructure are of structural steel, the floor system of reinforced concrete.

The elevator system of these buildings —the last word in elevator engineering— is the largest single installation on record. There are, all-told, ninety-six elevators, of which six are for passengers. The freight elevators, which are of the self-levelling type, are automatically controlled by dispatchers, each of whom controls one bank of elevators. All dispatchers are grouped at a central station on the third floor, from which the movements of all elevators are directed by means of push-buttons. By the pressing of a button, a car may be dispatched to any floor, and as the car reaches the floor desired, the doors on that level automatically open. They remain open until closed by the pressing of a button by the freight-handler, when the central operator may again dispatch the car. Elevators are operated on a pre-arranged schedule, but a telephone unit which is provided enables freight-handlers to communicate with the central operator when necessary.

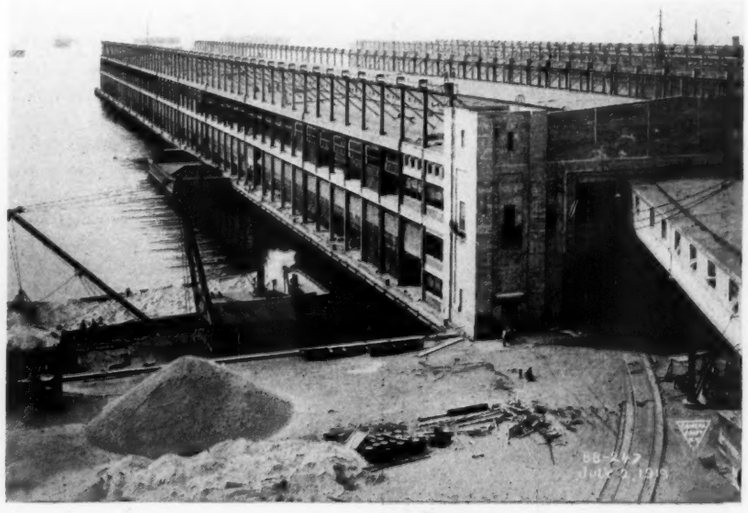
Although the Base has been designed as a war emergency, due consideration was given to its possible use in peace times under private ownership. Accordingly, local building ordinances were conformed to, even where this policy was contrary to more economical practices. The buildings may therefore be readily converted to peace time uses.

Begun in May, 1918, and practically completed in January, 1919, the construction of the Brooklyn Army Supply Base may be considered a marvel of speed and efficiency and a monument to American skill and energy.

The successful results obtained were due to the wholehearted co-operation of all concerned. The plans were prepared by Mr. Cass Gilbert, Architect, and the contractor was The Turner Construction Company. Lieut.-Colonel H. S. Crocker, U. S. A., with a staff of officers, supervised the construction under the direction of Brigadier General R. C. Marshall, Jr., Chief of the Construction Division of the Army.

NORTHWEST VIEW SHOWING WAREHOUSE B

One hundred acres of storage space are provided, fifty-one acres of which are in Warehouse B.



EXTERIOR OF PIER NO. 3

The three double deck piers are the largest in New York Harbor, each being 150 feet wide and 1300 feet long.

THE RECOGNITION OF FELLOWSHIP

By HENRY S. DENNISON
President of the Dennison Manufacturing Co.

You ask my opinion as to what are the fundamentals of fair relations between employer and employee upon which we can build an economic democracy that will supplement and complement our political democracy.

There are many important influences which will help or hinder the movement toward industrial democracy: sound or unsound methods of wage payment, good or bad physical conditions in the factory, the existence or absence of an able employment or personnel manager, progressive or restrictive measures by trade unions, the existence or absence of a means of employees' participation in management through Works Committees; but these are institutional devices, not fundamentals. The fundamental is the recognition by employer and employee of the manhood of his co-worker. Without this recognition the soviet and the capitalist boss are equally undemocratic.

This recognition of fellowship is easy to preach about, but hard to apply. I have found a great deal of help in its application from the analogy to be drawn between employees and customers. We have about 100,000 customers and 2,000 employees. We could lose a few from either list without going out of business, but it is our business not to lose them. Neither makes our profit for us, though it is easier to think of the customer as doing so because he comes last in the whole train of transactions the co-ordination of which results in a profit. In these days of the shrunken dollar it is easier than usual to see in the employee's purchase of our money for his efforts the same significance as in the customer's purchase of our goods for his money.

The long-time customer, thoroughly "sold" to our goods, has an analogous value to the long-service employee thoroughly loyal and acquainted with his job.

Our external good-will account consists in such reputation as we may have for square dealing, simple straightforwardness, and tact; our internal good-will account can be measured in much the same phrases. The one makes easier the selling of our goods, and the other their manufacture. Who shall say which of these accounts is the greater?

We hire 250 salesmen, chosen and trained for wisdom and tact in dealing with customers. We have foremen in whom the same qualities can produce similarly valuable results in their dealing with their fellow employees.

When we take on a new customer we are most solicitous that his first impression should be favorable, that his needs should be thoroughly studied and our goods carefully chosen to fit them. Only recently have we realized that the first impression given by the reception which a prospective employee receives at our factory is of many times greater importance, and that the fitting of his abilities to our needs for service is certainly of equal value.

That each of our 2,000 employee manual workers should play his part with interest and enthusiasm is certainly as important as it is that each of our 10,000 agents should display and sell our goods with interest and intelligence.

We know that it does not pay to truckle to customers any more than it pays to be stiff-necked and refuse to meet their arguments, and the terms of our dealings with them, while necessarily finally determined by us, are not so determined without previous consultation of their interests and opinions. The same man-to-man attitude is as right and as profitable when applied to relations with employees.

We have been squeezed a few times by customers, and while we did not like it and found some way eventually to work out of the injustice, we did not rant and lose our heads over it; when squeezed by employees the same cool reaction is no more than good sense.

Any failure of courtesy or consideration to the customer during the sellers' market of 1916-19 will be regretted when the market turns; a large part of the penalty which management is paying to-day was earned during the employers' labor market of 1913-1914.

It was not so long ago that big business discovered that the "public be damned" attitude was really "customer be damned" attitude, and did not pay. The shortage of labor is helping management to learn that the "employee be damned" attitude is still more expensive financially and ethically.

The analogy can be carried farther, and retains much of the same helpful significance when applied to any specific case which may be trying the soul of management at the moment. I believe it to be a most useful guide through some of the mazes of readjustment which face us to-day.

PERFECTION OF THE HABER PROCESS

Because of the growing importance of the nitrogen fixation industry in this country, considerable interest attaches itself to the work of the chemical department which has as its aim the removal of the excess CO which is produced in the Haber process. By the process developed for its removal, it is claimed that a very definite improvement has been affected.

HELIUM GAS

By FRED E. NORTON, '91

The development of a non-combustible gas, of good lifting power, for all balloon purposes, is such a desirable thing, that it is not surprising that the war led to a strenuous effort to separate large quantities of helium from the enormous gas supply in certain fields. Helium has a molecular weight of 4 against 2 for hydrogen, hence its lifting power is about 92.6 per cent that of hydrogen. Helium is monatomic.

The Petrolia, Texas, field alone has in the past delivered as much as 30,000,000 cu. ft. of natural gas per day carrying as high as 300,000 cu. ft. of helium to waste in the furnaces and stoves of the cities of Dallas and Fort Worth. Even greater quantities of gas exist in Ohio, but the helium content is much less.

It appears that natural gas carrying 1-3 to 2-3 per cent helium is available in immense quantities, and it only remains to separate the helium cheaply to make ballooning perfectly safe, particularly against accident from fire.

However, it is no small problem to liquify a gas which may consist of 30% nitrogen, 50% methane and 19% ethane, propane, butane, etc. Fortunately, the remaining 1% of helium need not be liquified, since its boiling point is 4 1-4° C abs. The nitrogen and methane liquify at minus 195.65° and 161.7° C respectively, and these temperatures are not difficult to reach.

Three plants were installed during the war. Two of these were located at Fort Worth, Texas, and both produced some helium at a very high cost, say, from $200 to $300 per thousand cu. ft.

The third plant was located at Petrolia, Texas, immediately at the gas wells, and unfortunately depends on the operation of a privately owned and operated gas compression and gasoline extraction plant.

The interference of the residual gases, ethane, propane, etc., from the gasoline extraction system, has prevented even a study of the operation of this plant under proper conditions.

It is evident that if the condensing system becomes cold enough to condense nitrogen, for instance, the sudden admission of even methane would at once put the condensing system out of commission, while a gust of ethane would be even worse.

Under the most adverse conditions, as to variable gas supply, the plant has been operated for about one year. Helium up to 20% has been recovered in small quantities, and it only remains to remove the external difficulties and to provide reasonable control over the gas supply to make an increased output and higher purity a matter of natural sequence.

(Continued on page 14)

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CITY MANAGEMENT

The close of 1919 found one hundred sixty-five cities and towns throughout the country governed under or pledged to the city-manager form of municipal administration. That total, reached in a period of seven years, is higher than any which might have been hoped for by the most ardent supporters of the city-manager plan when back in 1912 a few of the larger Ohio cities gave a real impetus to the movement. Such noticeable success indicates that the plan has passed the experimental stage and that there is ample justification for bright hopes concerning its future.

Briefly outlined, the standard form of plan is as follows:

A commission composed of five members is elected from the city at large on a non-partisan ballot. The commissioner's term of office is four years and elections are held every two years so the commission does not change bodily. A petition signed by five per cent of the voters puts the prospective candidate on the ballot and at the polls the candidates receiving the greater number of votes win the offices. This commission acts as the city's legislative body. Its one other duty is to appoint a city clerk, solicitor, treasurer, and the man who is to act as the executive head with the title of city-manager.

The manager is chosen with no attention directed towards things political. He need not even be a citizen. Executive ability and vision are the requisites. He is chosen just as a board of directors would choose an executive to direct the fortunes of a large industrial organization. Once selected, the municipal executive functions just as does the industrial executive. He is intrusted with complete control of the various administrative departments of the city and with the supervision of whatever public utilities the city may own. His attention is directed toward that coordination of effort which will result in the maximum benefit to the city at a minimum cost to the tax-payer.

NEW DORMITORIES

There is, in all probability, no problem facing Technology men at present of greater interest or of more vital concern than that of new dormitories. For this reason the thesis done by Course IV men on new housing arrangements for Technology students is timely and noteworthy. Following the suggestions of the committee which has been conducting investigations of college dormitories throughout the United States, these men have made plans and estimates for a new dormitory group to accommodate 500 men. Although such an addition to the present dormitory system would definitely improve present conditions, it would obviously be entirely inadequate to house those men seeking homes in Institute dormitories. Besides about 1500 individuals, 7 of the fraternities have signified their desire to have accommodations in the new dormitories. In as much as we can hardly hope to have a complete system for some time to come, this partial solution of our problem would appear to be eminently worth while. It would be well if immediate action might be taken in regard to this matter by those in a position of authority.

The necessity of providing new accommodations for the students of Technology in only too evident. At present many men are living under conditions which are conducive neither to health nor study. If the means for the carrying out of the project are not readily forthcoming, special effort must be made to interest those in a position to provide financially for the buildings. Whether the seemingly excellent thesis suggestions made by the men who have been making a study of the situation are carried out or not is of little moment. The details may well be left till a later date for settlement. The sooner undergraduates make their attitude definitely known on this question the sooner will their influence be felt and results be obtained. Half-hearted support of the project is useless. Either we must get squarely behind it and push vigorously or give the idea up. Can there be a loyal supporter of the best interests of Technology who is willing to see the project of new dormitories fail?

Graduates of the Institute are noted as men of decision and action. Let our student body show itself worthy of the same distinction by shouldering its responsibility in this matter. Thus and thus alone can we win out. We need and must have dormitories, if Technology students are to live in the future as other college men live.

MUSCLE SHOALS

In the May issue of THE TECH ENGINEERING NEWS, there appeared an article headed "Technology Men at Muscle Shoals." The editor wishes to correct the statement that Captain Grant is to be connected with the construction of the Wilson Dam at Muscle Shoals. He has for some time been working there. A typographical error also was made in the dimensions of the dam. It is 96 ft. high by 76 ft. wide at the bottom and 25 ft. wide at the top.

LETTERS TO EDITOR

Department of Public Works of Canada

Ottawa, May 7, 1920.

Editor, THE TECH ENGINEERING NEWS

Dear Sir:

I think the best information I can give you on a National Department of Public Works, is to outline the development of the Canadian organization along this line, leaving you to judge whether a similar organization would be beneficial and effective in your country.

Dating from the earliest settlement of Canada, there has been a building organization which at first confined its activities to the building of roads, bridges and public buildings. The latter embraced court houses, prisons, asylums, executive buildings and institutions for higher education.

In the year 1835, a Board of Works was organized and took over numerous public works which had been projected or completed under special Commissioners appointed by Parliament. These works included, canals, harbor works, piers, wharves and breakwaters, as well as aids to navigation, such as lighthouses, beacons, etc.

At Confederation in 1867, the control and management of municipal roads and bridges, court houses, jails, asylums and charitable and educational institutions were transferred to the different Provinces and the Federal Department of Public Works was established and given control of—

Canals and works on navigable waters.
Dredging and Dredging Plant.
All public harbors and piers.
Slides and booms built by the Government for facilitating the passage of timber in navigable waters.
Military and Interprovincial bridge.
Public Buildings to accommodate Federal Services, including Post Offices, Custom Houses, Inland Revenue buildings and drill halls, etc.

Subsequently the duties of the Department of Public Works were increased by taking over the construction and management of Government railways, the construction and management of Government telegraph lines along the sea coasts and in the sparsely settled districts in the interior, and the construction and management of dry docks.

In 1879, the Department of Railways and Canals was established and relieved the Department of Public Works of the construction, maintenance and management of canals and Government-owned railways.

The Department of Marine and Fisheries was established in the year 1868, and was given the control of aids to navigation, construction of lighthouses, buoys, beacons, etc., and the improvement and maintenance, by dredging, of the ship channel in the St. Lawrence River from Montreal Harbor eastward.

This has led to overlapping, to some extent by the departments in as much as Public Works dredges will be found at work in harbors along the St. Lawrence River, while the Marine Department, dredges are operating in the ship channel. It also leads to overlapping, in a measure, in connection with surveys.

There are also two other departments that do some building:

The Department of Justice construct additions and make improvements to penitentiaries, which was considered advisable as almost all such work may be done by convict labor, and it was not deemed well to have dual responsibility.

The Militia Department has complete control of fortifications, small drill halls and armories; that Department being also in a better position to know their military requirements than another.

Yours very truly,

W. R. HUNTER,

Deputy Minister of Public Works, Ottawa, Canada

EMPLOYMENT SITUATION

Editor, THE TECH ENGINEERING NEWS,

Dear Sir:—

Industry today is vitally concerned with the man power of our nation—concerned with this all important item because of the fact that big business has come to realize that the developing of the human factor is really its chief product and that the merchandise which it produces is merely a by-product.

The Goodyear Tire & Rubber Company of Akron, Ohio, realizing that this is true, is manning its organization with the best technical talent that the country is producing and is training these men with a view toward placing them where they can make the human equation balance—namely, where the desires of the men match up with and equal their capacities.

In order to do this Goodyear has instituted a training course which naturally divides itself into two parts. The first part of the course is so organized as to put all men who enter the organization through a general training in the factory on actual factory operations. On this part of the course, which requires from three to six months, each man is given an opportunity, not only to learn Goodyear's product and factories, but also its policy and methods of doing business. By means of the general course the men are picked for the particular field for which they are best adapted and have a desire to enter. They are then ready to enter the second part of the training course which consists of from one to three months in the special field that has been picked for them, at the end of which time the work is gradually tapered off so as to put them on a producing basis.

During the entire training course the men are given the opportunity of attending lectures on the theoretical side of the work through which they are passing and on rubber manufacturing practices in general; these lectures being clarified from time to time by means of moving pictures of the various operations.

While on this course, and afterwards, the entire resources of Goodyear's Industrial University are thrown open to these men. This is the largest project of its kind in the United States (having just been completed at a cost of two and one half million dollars) and includes both mental and recreational facilities.

In order to make Goodyear's product the best in the world, it has been necessary to build up an organization which includes and requires every source of training available, thereby making it possible for Goodyear to make an attractive offer to every technical man, regardless of what he may have specialized in. Goodyear has a place for you, Mr. Technical Graduate, and will be pleased to tell you more if you are interested in forming a connection with an organization which believes that the developing of men is its product and rubber goods its by-product.

Very truly yours,

THE GOODYEAR TIRE & RUBBER CO.

C. A. Palmer, Factory Personnel Div.

April 28, 1920.

Editor, THE TECH ENGINEERING NEWS,

Dear Sir:—

As to employment, it may perhaps suffice if I say that in our own line of fabricated steel work the only openings at present are in the drafting room and shops. Fortunately, these are the two departments where a novice should start, and while the work may at first be hard or even unattractive, the present rate of pay is higher than was formerly frequently given to responsible heads. However, when a man begins, the important thing is not what he does or the compensation received. Care should be taken to make business connections only with establishments of recognized standing.

So far as the business outlook is concerned, it has been for the past six months what we call a seller's market, by which we mean that more business is offered than can conveniently be booked. This is due in no small measure to the fact that the mills, on which we are dependent for our supply of raw material, are unable to run at anything like full capacity, this in turn being due to labor disturbances, such as coal and railroad strikes. There is no indication of any change in the character of the market during the current year, which is about as far ahead as one may see.

Yours truly,

ARTHUR L. DAVIS,

Division Contracting Manager, The American Bridge Company.

ALUMNI NEWS

Louis Barnett '09, has become sales engineer with the Multiple Electric Products Co., Inc., New York City, having been associated with the American Sugar Refinery of Brooklyn since his graduation. In this connection he has had varied experience with electrical apparatus.

Rudolph H. Fox '12, formerly manager of the Detroit district, Guerney Ball Bearing Co., Jamestown, N. Y., has been made Eastern representative, with offices in Hartford, Conn. Mr. Fox, up to the time of the war was with the Fafnir Bearing Co., New Britain, Conn., in charge of steel analysis and heat treatment. During the war he served as an officer in the Ordnance Department.

C. W. Whitley '91, who is director of the American Smelting & Refining Co., is making an extended inspection of the properties of the company in the Southwest. Mr. Whitley formerly was general manager of the company, with offices at Salt Lake City, Utah.

James Reed '07, has resigned as commander in the Construction Corps of the United States Navy and has been added to the executive staff as assistant general manager of the Los Angeles Shipbuilding & Drydock Co., San Pedro, Cal.

Edward G. Gustafson '01, wes recently elected treasurer of the Independent Pneumatic Tool Co., Chicago, Ill.

L. D. Davenport '07, for the last four years chief engineer in the Hibbing district for the Oliver Iron Mining Co., has resigned and will become associated with E. M. Thayer & Co., of Boston. Mr. Davenport is one of the pioneer engineers of the Mesabi Range, and in addition to having published several original articles on Mesabi mining practice, has lately been editor-in-chief of the handbook of mining methods being prepared by the Engineer's Club of Northern Minnesota. On April 24, a farewell banquet was tendered him by the club.

Thomas A. Clark '13, formerly treasurer of the Standard Engineering Co., Ellwood City, Pa., recently became general manager of the company.

Dr. Willis R. Whitney '90, director of the research laboratory of the General Electric Co., at Schenectady, N. Y., was recently awarded the Chandler medal for scientific achievement. He received the medal on April 27, at Havemeyer Hall, Columbia University, New York City. Dr. Whitney made an address on "The Littlest Things of Chemistry".

Samuel B. Sheldon '89, who for the past seven years has been superintendent of the Duluth plant of the Minnesota Steel Co., has been appointed vice-president of the company. Since his graduation, he has held many important positions in the steel industry. Serving first as chief chemist for the Otis Steel Co., Cleveland, Ohio, he was soon promoted to the position of superintendent of the Bessemer open-hearth departments. He then became superintendent successively, of the Joliet works of the Illinois Steel Co., of the Lackawana Steel Co., Buffalo, and of the Saucon works of the Bethlehem Steel Co. In 1909, he became consulting engineer, remaining in that capacity until 1913, when he became superintendent of the Minnesota Steel Co.

INDUSTRIAL AND CONTRACTORS LOCOMOTIVES

The motive power requirements of contractors and industrial service are exceedingly varied, and it is not generally realized how many different designs of locomotives are used in this class of work. In the majority of cases, the locomotive builder must prepare new designs for locomotives intended for industrial service. Certain sizes of contractors' locomotives can be kept in stock and profitably disposed of, but the industrial haulage proposition presents such a variety of conditions that locomotives of special design must be built in almost every instance.

Figure 1, shows an industrial steam locomotive of the mining type, used by the Granby Mining and Smelting Co. at East St. Louis, Illinois. This machine is of 3 ft. 0½ in. guage, and weighs 17,000 lbs.; and it was designed with a height limit of 5 ft. 1 in. and a width limit of 5 ft. 0 in. In order to keep within the width limit it was necessary to place the cylinders inside, in an inclined position, and use a crank axle on the second pair of wheels. The water supply, amounting to 200 gals. is carried in the side tanks; and 500 lbs. of coal can be carried in a fuel box in the cab.

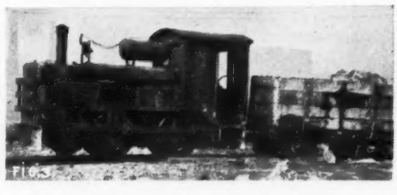
This locomotive, while representing a type primarily designed for mining service, is well adapted to service haulage where clearance limits are unusually restricted.

Figure 2, is a view on a logging railroad in Washington, operated by the Os-

trander Railway and Timber Company. Such service is exceptionally severe, as tracks are usually rough, curves are frequent and sharp, and grades are steep. The locomotive shown is of standard gauge, with three pairs of coupled driving wheels and a two-wheeled radial truck at each end. This is a safe wheel arrangement for work where tracks are uneven, and the locomotive must enter sharp curves and switches when running in either direction. This locomotive carries 900 gals. of water in the two side tanks, and one cord of wood fuel in the fuel-box back of the cab; and it weighs, loaded, 82,350 lbs. Where it is necessary to make a comparatively long haul from the woods to the mill, it is preferable to use a locomotive with a separate tender, so that a sufficient supply of fuel and water can be carried.

Figure 3 shows a Baldwin internal combustion locomotive in service. Locomotives of this type, first built in 1910, have demonstrated their fitness for work in contracting operations, plantations, quarries, brick yards, lumber mills, smelting plants, light switching in railroad yards, and other classes of service where loads are to be hauled at moderate speeds and within the range of available motor powers.

These locomotives follow steam locomotive design as far as is practicable, and are built in five standard sizes, weighing from 5 to 25 tons. A special feature of their construction is the transmission system, which is arranged with a positive drive from engine to wheels, all chains and flimsy devices being eliminated from the construction. Baldwin internal combustion locomotives can be equipped to burn gasoline, naphtha, alcohol, kerosene, or distillates of 42° Baumé or higher, and having a flash point of not over 120° F.



While there are no present prospects that the internal combustion locomotive will be extensively employed in heavy railroad service, this type of motor presents interesting possibilities; and its increasing use in light industrial and special service may be expected in the future.

THE FIELD OF THE GAS INDUSTRY

By Dr. J F. Wing

(Boston Consolidated Gas Company)

The technical branches of the Gas Industry in all its kinds and in all its ramifications are preeminently engineering subjects. The manufacture and application of artificial gases belong especially to the domain of chemical engineering. If this is understood it will readily be credited that the masters and leaders in the industry are generally the product of technological schools.

The recent development of the industry in the application of artificial gas is to standardize the product no longer as an illuminant but as a fuel; and it is now regulated as such in England, Canada and the United States, except in some few districts where political reasons have prevented the reference to a logical standard.

This change is a consequence of the greatly increased relative use of gases for heating purposes. Even when competing in the lighting field with the electric light, its utility no longer depends in an important degree on its luminosity as such, but on its capacity for heating a mantle, just as electricity heats a filament.

The substitution of gas for solid fuel in the home and its resulting freedom from inconvenience and from nuisance, is paralleled by its expanding use as a fuel in industries for the same reasons, even in some cases as a steam boiler fuel. These are well founded reasons for the past expansion of the industry and a certain indication that it is bound to grow and become one of the greatest manufacturing industries, and vital to the congested areas of the nation.

This is becoming a "Gas Age" in respect to fuel. It is a fact that in metallurgical and other heat consuming industries, processes for the development and utilization of gaseous fuel, as well as the saving of waste heat in gases, are at a premium, on account of their economics.

It is illustrative that in England there is now great interest in the project of the complete gasification of coal in a gas works, and distributing a gas rather leaner than the present standard, but in great volume, and at low price, which would substitute for all domestic and most industrial uses of coal and coke.

The gas industry is not new, but new inventions in manufacturing processes and new utilizations are being introduced. In fact their multiplicity is great and a judicious selection is confusing. The industry is adjusting itself to fulfill its true role and scope.

There is an opportunity full of promise for new men to examine complex and unsettled problems and develop the art and industry as its possibilities warrant, and its importance in the economy of the nation deserves.

There is need now for more men, energetic, ambitious and persistent, to take up a career in this important and responsible industry. If, on a closer acquaintance, the occupation impresses a man as congenial, the opportunities should invite a chemical engineer to risk his future in the future growth of the gas industry.

DRYING AUTOMOBILE PLATES

It would seem that inmates of Massachusetts jails are about to benefit from the work of two Course X men. A new method for drying the paint on the automobile license plates, which are made in the Charlestown jail, has been developed by which the time required for this operation has been much reduced. Moreover the results obtained appear to be superior to those obtained by the method previously in use.

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"What made you think you needed motor trucks?" was the counter-question.

"Everyone else seems to be turning to gasoline delivery. I want to be up to date."

"Your delivery problem lies outside the gasoline field," said the salesman. "Your drivers make an average of ninety stops each trip. They climb stairs and wait for receipts. Their rigs are standing at the curb more than half the time. Nothing in gasoline equipment can compete with the horse and wagon under such conditions. If you had loads of several tons to be kept moving steadily I'd be glad to sell you trucks."

"Suppose I wanted to buy them, anyway?"

"We could not accept your order."

"But you'd make your commission and the company its profit."

"Yes; but you'd make a loss, and within a year your experience would react unfavorably upon us."

So no sale was effected. Facts learned during his investigation of this business man's delivery problem led the salesman to make suggestions that eliminated waste and increased the effectiveness of his horse rigs.

About a year later, however, this business man sent for the salesman again. He contemplated motorized hauling for another company of which he was president. After two days' study, the salesman reported that motor trucks were practicable and that he needed about five of them.

"All right, fill out the contract," directed the business man.

"Don't you want to know how those trucks are going to make money?" asked the salesman.

"No; if you say I need five trucks, then I know that's just what I need!"

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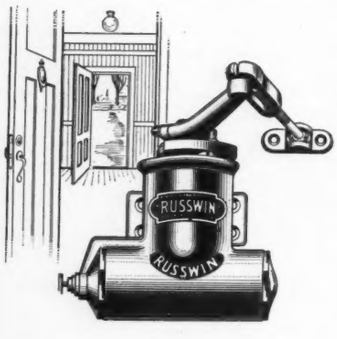

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HELIUM GAS

(*Continued from page 9*)

The system used at Petrolia differs from the other plants in that the gas is liquified and distilled at a pressure of 300 lbs. per sq. in.

Very powerful expansion engines, three in number, expand the gas after separation, and their very cold exhaust serves to refrigerate the interchanger system. These interchangers resemble counter current condensers, and have about 14,000 tubes, and a surface of 8,000 sq. ft. is available to cool and condense the gas.

The stills are essentially of standard type, except that they are maintained at high pressure. As high a ratio as 80 has been reached in the relative helium content of gas treated and the discharge of still.

The economical production of helium depends altogether on the seemingly independent matter of freeing the gas from gasoline vapors.

GASOLINE ECONOMIZERS

One of the most interesting researches in gas-engine fuels that has ever been conducted at the Institute has just been completed by two Course XV men. The investigation covered the use, in automobile engines, of certain solvent "gasoline economizers" which have recently come before the public. By use of storage and measuring apparatus the amount of gas or mixture used in a single run over a fixed course was accurately measured. Runs were made with varying percentages of the "economizer" and comparisons were then made of the relative mileages obtained.

RECOVERY OF ANILINE

In the dye industry, aniline is of prime importance as a basis for the production of synthetic dyes. By the present process of manufacture about 5% of the possible yield is lost. A recovery process, now being perfected by Course X men, makes possible a saving of about 70% of the amount formerly lost. Since raw aniline sells at about ninety dollars per ton, this saving is well worth while from the commercial standpoint.

CRACKING PETROLEUM

By the method now in use, a temperature of about 700° c is required in the cracking of crude petroleum. Investigations are being carried on in the Chemical Engineering laboratories, to determine the possibility of cracking the oil at lower temperature. Considerable progress has been made and the perfection of the new process appears quite probable.

Just as record.

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To be admitted to the Institute, the applicant must have attained the age of seventeen years and must pass examinations in Algebra, Plane and Solid Geometry, Physics, History of the United States (or Ancient History), Trigonometry, English, French and German. Preparation in two of a series of elective subjects is also required. A division of these examinations between different examination periods is allowed. In general, a faithful student who has passed creditably through a good high school, having two years' study of French and German (or three years of French or German) should be able to pass the Institute examinations.

Graduates of colleges, and in general all applicants presenting certificates representing work done at other colleges, are excused from the usual entrance examinations and from any subjects already satisfactorily completed. Records of the College Entrance Examination Board, which holds examinations at many points throughout the country and in Europe, are also accepted for admission to the Institute.

Instruction is given by means of lectures and recitations, in connection with appropriate work in the laboratory, drawing-room or field. To this end, extensive laboratories of Chemistry, Physics, Biology, Mining, Mechanical Engineering, Applied Mechanics, and the Mechanic Arts have been thoroughly equipped, and unusual opportunities for field-work and for the examination of existing structures and industries have been secured. So far as is practicable, instruction is given personally to small sections rather than by lectures to large bodies of students.

The regular courses are of four years' duration, and lead to the degree of Bachelor of Science. In most courses the work may also be distributed over five years by students who prefer to do so. Special students are admitted to work for which they are qualified; and the degree of Master of Science, Doctor of Philosophy, and Doctor of Science are given for resident study subsequent to graduation. Opportunity for research is offered in all the departmental laboratories, in the three recently established Research Laboratories of Applied Chemistry and Physical Chemistry, and in the Sanitary Research Laboratory and Sewerage Experiment Station.

The tuition fee, not including breakage in the laboratories, is $250 a year ($300 next year and thereafter). In addition, $40 to $50 per year is required for books and drawing materials.

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THE AMERICAN RAILROAD SITUATION

(*Continued from page 1*)

increase in the total money cost? The answer must be negative to both questions. In 1915 the total freight service for our directly operated lines was 24,300,000,000 ton-miles and last year 27,100,000,000 ton-miles, an increase of only 11 per cent. It is true that the passenger-miles grew from 2,500,000,000 to 4,500,000,000 in the same period, but the overwhelmingly dominant importance of the freight service, from an operating point of view, in American railroading as it has thus far been developed, minimizes the actual effect of this relatively large increase in the passenger traffic. Even if we lump ton-miles and passenger-miles together and call them "traffic units," as is sometimes done for statistical purposes, we find that the service rendered in 1915 was equivalent to 26,800,000,000 traffic units, or an increase of only 18 per cent. To handle this 18 per cent increase in traffic, as I have just indicated, required 31 per cent more men, and 129 per cent more dollars were spent for wages.

Considering the question of efficiency only, what were the causes of this lessened output per man, despite the incentive of higher wages? I think the chief causes may be enumerated as follows:

The general lowering of the sense of personal responsibility, which, unfortunately, seems inseparable from "working for the Government."

Loss of many of our best men in the war, some temporarily, others permanently.

Establishment of the eight-hour day.

Inauguration of a rigid seniority rule regarding promotions and lay-offs, regardless of differences in individual ability.

Abolition of piece-work in the shops.

Diminution of the disciplinary powers of officers; brought about by sanctioning of appeals to Washington over decisions of officers on the spot.

The first-named cause—"working for the Government"—I do not propose to discuss at all, believing that its mere statement is sufficient. It is probably the strongest and most universally accepted argument against Government ownership as a permanent policy. The second cause, the war losses, was unavoidable and common to all enterprises.

With the eight-hour day, I have no quarrel in principle. I only regret that in the case of the railroads its establishment has not verified the predictions of its endorsers that the shorter day would bring greater efficiency. With us it has not done so thus far. Rather, the reverse has unmistakably come about.

The hard and fast seniority rule destroys the incentive to individual effort and enterprise and makes for stagnation. Seniority is correct as a broad underlying principle, but there should be discretionary authority to make selections for promotion and, when forces are being

reduced, there should be some more intelligent rule of picking those who are to stay than the mere question of priority of dates on a service record. The seniority rule has been carried to illogical extremes, protecting the inefficient and careless and discouraging the willing and ambitious.

Piece-work is a correct principle of wage payment and should be adopted wherever practically applicable. It means payment for what a man actually produces. It is peculiarly fitted to shop forces. When piece-work was abolished two years ago at our Altoona shops, and all men were put on an hourly basis of payment, regardless of what they turned out, we continued our piece-work record cards until the Railroad Administration in Washington ordered them discontinued. In the two months, however, that this record was maintained, it showed that the production per man per hour actually fell 34.3 per cent. If these records were kept to-day, it is believed the reduction in out-put would be fully 40 per cent if not more. This experience alone condemns the change.

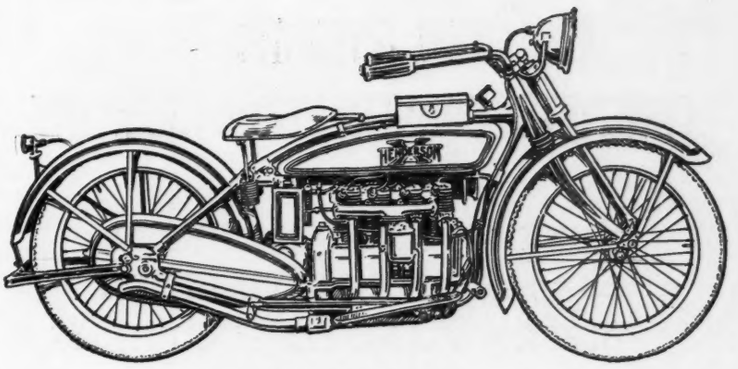
The reducing of the disciplinary powers of employing officers under federal control, and the sanctioning of direct appeals to Washington from disciplinary measures, were practices which have had a very bad effect on morale. I do not intend to discuss them in detail, but it is a pity they were permitted.

During 1915, for every dollar of operating pay roll we carried an average of 23.1 tons of freight and 24 passengers one mile—a total of 255 traffic units. In 1919, for each dollar of operating pay roll we carried an average of only 115 tons of freight and 19 passengers one mile—a total of only 134 traffic units. The productive power of the dollar, spent in railroad wages and measured in transportation service rendered, had fallen 47.5 per cent.

Now let us look at this in the terms of the smallest figures used in railroading; the revenues and expenses per ton-mile and per passenger-mile. In 1915, for each ton of freight carried one mile, we received 6.35 mills and spent in rendering the service 4.45 mills. We thus had a profit of 1.9 mills for each ton-mile. During 1919, our average gross revenue had risen to 8.96 mills per ton-mile, but the expenses had jumped to 8.68 mills, so that we had a profit of only 0.28 of a mill for each ton of freight carried a mile.

In 1915, our passenger service produced a gross revenue of 1.996 cents for each passenger carried one mile, and the expenses were 1.735 cents, making a net profit of 2.61 mills. In 1919, gross revenues averaged 2.458 cents per passenger mile, while expenses had risen to 2.216 cents, leaving a net profit of 2.42 mills for each passenger carried one mile.

The insignificant little decimal of a



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theoretical coin formed the margin of the earning power on which the comparative prosperity of our railroad rested last year. But such a margin, or something better, small as it seems, must absolutely be maintained if the solvency of the railroad is to continue.

Why has the margin that existed in 1915 not been maintained to-day? The answer is obvious. Wages increased about 90 per cent, and the cost of materials, in general, about 70 per cent, while rates have risen for both passengers and freight an average of about 34 per cent. In other words, the cost of rendering service has risen more than twice as fast as the price received for the service. This is a situation which must be remedied. No other business could stand it. Neither can the railroad business stand it indefinitely.

In three years, from 1916 to 1919, the average wages per hour of all clerks on our directly operated lines east of Pittsburgh rose 69 per cent, and the man-hours of the clerical forces increased 35 per cent. The total clerk-hire per month rose from $1,271,000 to $2,887,000—or 127 per cent.

The increase per month for the pay of clerks was $1,616,000—or at the rate of $19,400,000 per year. Please remember that this is for the Lines East only. Making a fairly close estimate for the lines of the system lying west of Pittsburgh, gives us approximately $32,000,000 per year as the added burden from increased clerks' wages alone for the Pennsylvania system. The comparison to which I wish to draw attention is that a year's dividend on the entire $500,000,000 capital stock of the Pennsylvania Railroad Company requires only $30,000,000 so that the advance in the wages of only one class of employees—and by no means a relatively favored class—has wiped out a sum more than equal to our Company's full annual dividend requirements.

I have nothing whatever against the clerks. They were dealt with less liberally and more tardily than many other classes of employees. I merely mention these figures to visualize for you the immensity and reality of the burdens placed upon the earning power of the railroads by the wage increases. Some way must be found to meet these burdens if we wish to escape disaster.

I have spoken a number of times of decreased efficiency and its effects. Let me give one concrete case which I think will illustrate in a very vivid manner how rising wages and reduced efficiency interact to lessen the producing power of a dollar. I will concede that it is a rather extreme case, but as it affects a very large number of men and many millions of dollars in wages, it is a most important one.

We do not have definite figures as to decreased efficiency of all classes of em-

ployees. In most cases it is merely a matter of general observation that men, as a whole, are doing materially less work in a given time than they used to do. In the case of one particular class, however — namely, track laborers — we made a careful study because they constitute the most numerous class of our unskilled labor and because their wage advances have been relatively unusually large.

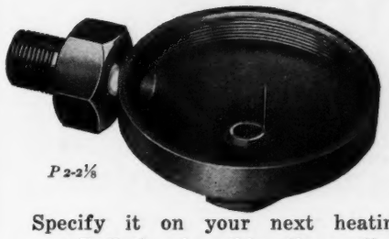
Before the era of war wages, we used to figure on paying trackmen about $1.75 per day. That seems very small now. It may have been too small then, although the purchasing power of a dollar at that time was considered more nearly normal. However, we met the general market and did a little better on this class of labor, and the figure I have named was about the accepted one. Now we pay trackmen about $4.50 per day, figuring in both cases upon 10 hours of duty.

We know, not by guess work, but by actual facts, that the average efficiency of trackmen in the last four years, has decreased over 40 per cent. This has been ascertained by repeated observations of the amount of work done by them in renewing rails, ties, and ballast.

A study of this which was completed last fall and which was based on the actual cost of the track work done on the Lines East of Pittsburgh during the five years from 1914 to 1918, showed that, in considering the amount of track material applied with the number of men employed and the number of hours consumed, at the close of the period, wages per man per hour were doubled, while it required twice as many men to do the work. In other words, where the railroad paid out $1.00 in 1914 for accomplishing a certain unit of track work, it paid out $4.00 in 1918.

A marked improvement has been shown in the track maintenance work since the beginning of 1919. For the first six months of that year, which is the closest that this particular study has been brought up to date, we found that where the $4.00 was paid out in 1918, it was then only necessary to spend $2.65 to have the same unit of track work done. That is very encouraging, and I believe we are going to continue to improve in this right along.

I have now stated some of the general factors affecting the railroad situation today from the point of view of the working forces. In addition, there is, as you know,



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a general shortage of equipment on all railroads. On our own road we need 250 locomotives, 8000 freight cars, and 500 passenger cars, as a minimum estimate. Altogether on the Pennsylvania system, to put it in condition to handle comfortably the traffic offered, there should be spent immediately a sum estimated at not less than $200,000,000, and from that up to four or five hundred millions, according to different views of the present needs and the extent to which we are justified in anticipating the future. It will be impossible at once to raise such sums as I have named. It will also be impossible, immediately, to restore the efficiency of the working force. What course, then, should be pursued for the present?

In the first place, it is necessary for all of us--both the railroad management and the public—to make the best use of the railroad facilities that we have at hand. For instance, if we could induce shippers to load only two tons more of freight in each car, that would increase the total carrying capacity of the country by an equivalent of about 200,000 freight cars. This is by no means an impossible performance, although I am well aware and fully appreciate that the shippers have done a great deal in recent years toward heavier car loading and deserve a great deal of credit for it.

In the second place, we must have increased freight rates because the price of transportation must be made commensurate with the cost of all the factors which enter into furnishing it. This is so elementary that I hardly think it needs to be argued and we may take it for granted that an increase will come. The point is to make the increase a sufficient one to restore the earning power and credit of the railroads.

An increase in freight rates will not in reality add to the cost of living. The cost of transportation is even now being paid in full by the public, but it is only partly being paid in the form of rates, the balance being made up out of taxation. By this I mean that any deficit which existed during the period of Government control, or which may result during the six month period dating from March, 1920, is made up out of Government funds received through taxes.

In the third place, we must restore personal efficiency, the sense of individual responsibility, loyalty to the job and the standards of courtesy and service which existed among the rank and file of railroad employees in former years. This will be a difficult task, and I am afraid a slow one, but I have great faith in the American people. I think they are rapidly coming to realize that the present state of affairs cannot go on indefinitely, and that to get as much as possible for the least amount of work done only tends to aggravate instead of improve the situation.

Almost every one in the country is suffering from a psychological unbalance,

due to the illusory and deceptive atmosphere of wealth and prosperity which has grown out of the extravagance connected with the war. There have been an abandonment of thrift and a dangerous delusion as to the possibility of creating wealth out of nothing which have affected almost every class of people in the country. Railroad men are no exception, but I cannot help feeling that they have also been subject to other unsteadying influences which were inseparable from the governmental operation of the railroads and the resulting contact with political influences.

It might be inferred from the emphasis I have laid on the great increases in the wage scales that I regard railroad wages at the present time as being too high. This is not, however, my view as to the general level compared with outside industry, although there have been exceptional cases in which unwarranted advances were given. On the whole, however, I believe an attempt to lower the existing scale of wages under present conditions, would be unwise and unjust and it may even be that there are still some cases in which the employees are not paid enough. We could stand the existing wage level if we had the old time loyalty and personal efficiency. And if the promised increase in efficiency that we were told would come with higher pay and short hours had actually been realized, we should be living in a sort of transportation Utopia. But as I have said, neither of these things has yet come about.

In regard to further wage increase for railroad employees, I wish to make my position clear. I am not an advocate of any movement to reduce wages. The present law provides, however, through the Railroad Labor Board that general increases of any moment shall not be made unless with the concurrence and uncoerced consent of the general public, which in the end pays all the bills of railroad operation, whether under Government management or private management.

It is very essential that the members of the Railroad Labor Board be men of the highest type and right caliber who are amply fitted, and properly compensated for the performance of the important duties which will rest upon them. Their decisions wherein wage increases are awarded will amount to millions of dollars in added railroad costs to the public, for the new Transportation Act provides that *all expenses* must *now* be taken into account by the Interstate Commerce Commission in considering the question of rates. Too much emphasis cannot, therefore, be placed on the importance of getting the proper men to represent the public, the men and the railroads on this Board, and one of the prime governing factors in securing these men is the amount of compensation for their service. This should be large enough to attract and hold *capable* men who are willing to render a public service such as this Board will be called upon to give.

BUILDING OPERATIONS IN 1919

Reports received by the United States Geological Survey, Department of the Interior, from the building officials of 114 of the larger cities in the country show that building operations in 1919 greatly exceeded those in 1918, both in number and cost. The number of permits issued or buildings erected in these 114 cities in 1919 was 309,551, as compared with 173,635 in 1918, an increase of 135,916 or 78 per cent. The cost of the operations in 1919 was $1,130,817,591 as compared with $369,252,315 in 1918, an increase of $761,565,276 or 206 per cent. If the operations in the remaining cities from which the Geological Survey usually receives statistics of building operations show a proportionate increase the number of permits issued or buildings erected in 1919 was about 377,000, which would cost about $1,300,000,000, so that the record for 1919 was the highest yet reached in the building industries in these cities in both the number and the cost of operations. The year of the next highest record was 1916, when 347,761 operations were reported, which cost $1,046,276,549.

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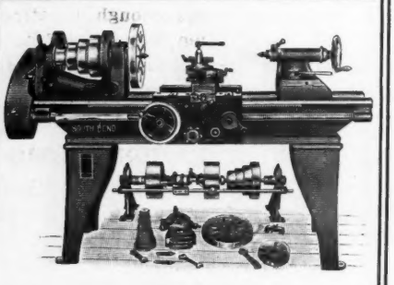

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RECOMMENDED ARTICLES

COURSE I.

Methods Employed in Sinking Large Open Caisson. ENGINEERING NEWS RECORD, May 6, p.p. 916-918. Library, Rm. 1-290.

Design and Operation of Movable Crest Dams, MUNICIPAL & COUNTY ENGINEERING, April, p.p. 157-159. Library, Rm. 1-290.

COURSE II.

Steam Turbines for Mechanical Drive. THE ELECTRICAL JOURNAL, April, p.p. 136-139. The application of small turbines with reduction gears to machines. Vail Library.

Vertical-Shaft Waterwheel-Driven Alternators, Mechanical features, POWER, May 4, p.p. 698-700.

COURSE VI.

Hydro-Electric Service West of Cascades. ELECTRICAL WORLD, May 8, p.p. 1061-1068. One of several interesting articles in this issue. Vail Library.

Proper Illumination a Factor in Increased Production. ELECTRICAL REVIEW, May 8. One of three articles on up-to-date illumination in this issue. Vail Library.

COURSE X.

Automatic Method of Gas Analysis Depending on Thermal Conductivity. JOURNAL OF INDUSTRIAL & ENGINEERING CHEMISTRY, April, p.p. 359-365. Chemical Library.

The Hot-Process Water Softener. CHEMICAL & METALLURGICAL ENGINEERING, May 12, p.p. 899-902. Plant equipment, reagent proportions, tanks and filter. Chemical Library.

COURSE XV.

The Housing Problem, FACTORY, May 1. Hoover on Industrial Relations. INDUSTRIAL MANAGEMENT, May, 1920.

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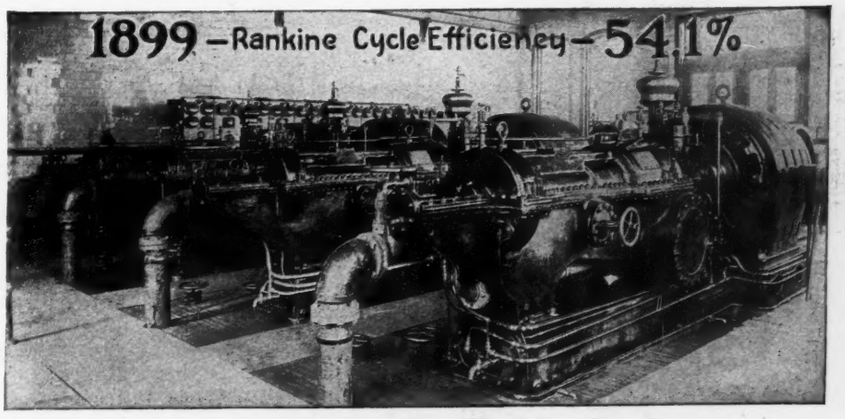

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